# RESEARCH BRIEF

## 20041110 029

# Using Game Theory to Analyze Operations Against Time-Critical Targets

**W**hen planning operations against time-critical targets (TCTs), military commanders typically think about how much capability they need to kill enemy forces. However, they also consider how their strategies will affect the enemy's behavior. TCT operations include suppression of enemy air defenses (SEAD), interdiction of moving forces, and attacks against theater ballistic missiles (TBMs). Convincing an enemy not to fire surface-to-air missiles (SAMs), not to move his forces, or not to launch TBMs is often a satisfactory short-term alternative to physically destroying enemy systems.

A study by RAND Project AIR FORCE (PAF) shows how military planners can use game theory to understand the effects of U.S. strategy and capabilities on the enemy in TCT operations. Game theory uses mathematics to model human decisionmaking in competitive situations. It is ideally suited for analyzing military situations because it depicts the realistic situation in which both sides are free to choose their best "moves" and to adjust their strategy over time. Military planners can apply these principles to TCT operations through game theoretic analysis. The method consists of the following steps:

- **Determine the tactical options available to each side.** For example, in a simple SEAD operation, the attacker can choose to fly a strike aircraft or a SEAD aircraft. The defender may choose to activate SAMs or to leave them inactive.

- **Assign a numerical value to each possible outcome.** Analysts represent commanders in the field by judging the potential gain or loss of an exchange. These numbers reflect real-world measurements such as the strength of a weapon system and the probability of hitting a target.

- **Calculate all possible strategies and their outcomes.** Intelligent opponents vary their tactics in order to appear unpredictable to the enemy. Thus, a combatant's overall strategy is determined by how often he chooses one tactical option over another. Analysts calculate all possible strategies and the net gain or loss to each side.

- **Find each side's optimum strategy.** Experience teaches that as opponents in a game adjust to each other's actions, each player will eventually settle on an optimum strategy. In military terms, the optimum strategy is not necessarily the most desirable outcome (i.e., winning the exchange), but the best that one can do against an opponent of given strength.

- **Determine the expected result of the game.** Having found each side's optimum strategy, analysts check to see whether the outcome of the encounter favors the attacker or the defender.

Game theoretic analysis enables analysts to see how an intelligent opponent is likely to behave in a given situation and which side is likely to win. If both sides correctly ascertain the situation, then the losing side may decide not to participate. For example, in a simple SEAD encounter, the defender might decide that preserving his SAMs is more important than attempting to shoot down strike aircraft if his chances of inflicting heavy losses on the attacker are small. Insights such as these help military planners to understand how much capability they would need to achieve the best outcome for their side. ∎

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